Patent
Attorney Docket No. GEMS8081.152

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	:	Foo et al.
Serial No.	:	09/682,685
Filed	:	October 5, 2001
For	:	Efficient Multi-Slice Acquisition With Black Blood Contrast In Fast Spin Echo Imaging
Group Art No.	:	3737
Examiner	:	Smith, R.

CERTIFICATION UNDER 37 CFR 1.8(a) and 1.10

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REPLY BRIEF RESPONSIVE TO EXAMINER'S ANSWER MAILED NOVEBER 19, 2004

Dear Sir:

This Reply Brief is being filed in response to the Examiner's Answer mailed November 19, 2004.

REMARKS

Before addressing the Examiner's Response to Appellant's Arguments presented in the Appeal Brief mailed October 28, 2004, Appellant wishes to note that although the serial number and filing date are listed correctly in the Examiner's Answer mailed November 19, 2004, the Appellant(s) and the Attorney's Docket Number are listed incorrectly. In an effort to avoid any future confusion, Appellant requests that the Examiner correct the Appellant(s) and the Attorney's Docket Number to be "Foo et al." and "GEMS8081.152", respectively.

With respect to the Reply Brief mailed November 19, 2004, claims 21-29 stand rejected under 35 U.S.C. §101 as being directed to non-statutory subject matter. Responsive to Appellant's Appeal Brief filed October 28, 2004, the Examiner addresses some of the remarks proffered by Appellant in the Appeal Brief filed October 28, 2004.

In particular, the Examiner asserts that Appellant's example is not convincing. Examiner's Answer, pg. 3. Appellant states that while fallen sticks of wood from a tree, which are a naturally occurring product of nature, are non-statutory subject matter, an arrangement of those same fallen sticks into a chair is patentable. Appeal Brief, pg. 5. While the Examiner acknowledges that a chair is statutory subject matter, the Examiner concluded that the claimed "pulse sequence which comprises forms of energy / ***a signal*** is not well recognized as such." Examiner's Answer, pg. 3 (emphasis added). The Examiner misunderstands Appellant's analogy by correlating the claimed pulse sequence with the fallen sticks.

With respect to Appellant's analogy, one may equate the occurrence of stray electro-magnetic fields to the fallen wood and the particular claimed pulse sequence arrangement to the chair. That is, naturally occurring electro-magnetic fields, like fallen sticks of wood, are indeed non-statutory subject matter. However, when electro-magnetic fields are directed by the hand of man to a practical application, it is not "naturally occurring", but is a practical application of the electro-magnetic fields and is, therefore, statutory subject matter. Appeal Brief, pg. 5. The Examiner provides no support that the claimed pulse sequence "occurs naturally" without the hand of man.

Nevertheless, the Examiner concludes that the claims do not positively set forth any practical application of the pulse sequence. Examiner's Answer, pg. 3. However, MPEP §2106.IV.B.1(c) is clear that "a signal claim directed to a practical application of electromagnetic energy is statutory." MPEP §2106.IV.B.1(c). The Examiner admits that claims 21-29 meet this criterion when stating that "the claims merely set forth a series of pulses of electromagnetic radiation with intended use that they be directed to a slab of slices in the patient's body." Office Action, pg. 2 (May 3, 2004). The Examiner again affirms this position by referring to the claimed invention as "a signal" that is directed to the application of MR imaging in the Examiner's Answer, as highlighted above. Examiner's Answer, pg. 3. Accordingly, the Examiner admits that the claim calls for a signal and its practical application is MR imaging. Therefore, the claim meets the statutory requirement of §101.

The Examiner failed to address the second pulse which specifically calls for a "slice-selective" re-inversion pulse applicable to at least a number of slices in the slab of slices. The very fact that this "re-inversion pulse" is "slice-selective" dictates that the pulse has a "practical application", contrary to the Examiner's assertion. It selects a slice. Accordingly, for this reason alone, claim 21 satisfies §101.

Even though the claims set forth the particular application of the pulse sequence as a signal and the Examiner acknowledged as much, the Examiner still asserts that the claims are directed to non-statutory subject matter because "the claims fail to positively set forth any ordered application of the pulses to achieve a practical application as inferred by the Appellant." Examiner's Answer, pgs. 3-4. The claim calls for a "pulse sequence." Sequence is generally defined as "a continuous or connected series." *See* Merriam-Webster Online Dictionary definition, attached. Synonyms for sequence include a "succession" or "order" such as a "progression" or "arrangement". *See* Merriam-Webster Online Thesaurus synonyms, attached. Moreover, the application illustrates the "pulse sequence" in Fig. 2. While Appellant knows of no naturally occurring instances of such pulses, claim 21 expressly calls for a non-selective pulse, a slice-selective re-inversion pulse, and a series of excitation pulses. Appellant claims that the series of excitation pulses are applicable to the number of slices in the slab of slices

after an inversion time. Appellant has not inferred anything -- the claim calls for a sequence of pulses, that as best known by Appellant, are not found to be "naturally occurring", and the Examiner fails to prove otherwise. In fact, by allowing the other claims, the Examiner has inferred that the sequence is, indeed, novel. See claim 21.

Where natural phenomena, such as electricity and magnetism are claimed, the courts have held that a signal claim directed to a practical application is statutory regardless of its transitory nature. See MPEP §2106.IV.B.1(c) citing O'Reilly v. Morse 56 U.S. (15 How) 62, 114-19 and In re Breslow, 616 F.2d 516, 519-21, 205 USPQ 221, 225-26 (CCPA 1980). Claim 21 calls for a pulse sequence *for use in multi-slice MR data acquisition*, a more practical application cannot be more explicit. Further, each element of the claim includes a practical application as to how the pulse sequence is used. For example, the non-selective inversion pulse is applicable to a slab of slices and the slice-selective re-inversion pulse is applicable to at least a number slices in the slab of slices. The series of excitation pulses is applicable to the at least a number of slices in the slab of slices after an inversion time. One skilled in this art will readily recognize the applicability of this signal claim to the very practical application of MR data acquisition.

As stated in MPEP §2106.IV.B.1, in the final analysis under §101 the claimed invention, as a whole, must be evaluated for what it is. See In re Abele 684 F.2d 902, 907, 214 USPQ 682, 687. In this case, when claim 21 is viewed as a whole, it is quite clear that the pulse sequence calls for use in multi-slice MR data acquisition. To say that the claim has no practical application ignores the requirement that the claim be reviewed "as a whole." The claim at issue does not call for an abstract idea, a physical phenomena, or a law of nature. It calls for a pulse sequence for use in MR data acquisition -- a very specific compilation.

Therefore, for the reasons stated in the Appeal Brief filed October 28, 2004, and the reasons stated herein, claims 21-29 are believed directed to a sequence of specific, uniquely tailored pulses that have practicality in MR data acquisition. That is, even though magnetism and RF emissions are naturally occurring phenomena and are thus not patentable in the abstract, when formed as a signal applied to MR imaging, as claimed, these phenomena are manipulated and exploited by the hand of man to acquire MR data.

By generating and manipulating magnetic fields and RF signals through a pulse sequence, the use of these phenomena are new and useful. In this regard, a "pulse sequence" defines the manner in which these naturally occurring phenomena are to be exploited to reach a new and useful end, namely, the claimed "multi-slice MR data acquisition."

While Appellant notes the close analogy to the Office issuing patents with patentable "manufacture" claims to a signal on a carrier wave (for example, USP6,791,971, claim 45; USP6,078,360, claim 5; USP6,076,092, claim 35; and USP5,995,921, claims 20-29), Appellant also notes the following patents that similarly call for a pulse sequence: see claims 1-4 of USP6,803,762, claims 21-29 of USP6,498,946, and claims 9-15 of USP6,526,307. Accordingly, Appellant respectfully submits that claims 21-29 are directed to statutory subject matter.

General Authorization for Extension of Time

In accordance with 37 C.F.R. §1.136, Appellant hereby provides a general authorization to treat this and any future reply requiring an extension of time as incorporating a request therefore. Prior authorization has been given authorizing charging Deposit Account No. 07-0845 fees associated with the above-captioned matter. Accordingly, Appellant requests that the $340.00 fee for filing this Appeal Brief Under 37 C.F.R. §1.17(c) be charged against Deposit Account No. 07-0845.

Respectfully submitted,

J. Mark Wilkinson
Registration No. 48,865
Direct Dial 262.376.5016
jmw@zpspatents.com

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Attorney Docket No.: GEMS8081.152

P.O. ADDRESS:
Ziolkowski Patent Solutions Group, LLC
14135 North Cedarburg Rd.
Mequon, WI 53097-1416
262-376-5170

APPENDIX OF CLAIMS ON APPEAL

1. (Allowed) A method of multi-slice image acquisition with black-blood contrast comprising:

applying a non-selective inversion pulse;

applying a re-inversion pulse that is slice-selective over a region encompassing a plurality of slice selections;

timing execution of a series of RF excitation pulses such that signal from blood is near a null point; and

acquiring data for the plurality of slice selections.

2. (Allowed) The method of claim 1 wherein the plurality of slice selections include all slice selections in a slab to be imaged.

3. (Allowed) The method of claim 1 wherein the images are acquired over more than a single breath-hold.

4. (Allowed) The method of claim 1 wherein the re-inversion pulse is applied over a region having all slice selections in a slab and data are acquired for all slice selections in the slab using a single re-inversion pulse.

5. (Allowed) The method of claim 1 further comprising creating the inversion pulse with slice thickness given by:

slice thickness = $(Z_1 - Z_n) + 4 * \text{opslthick}$,

where Z_1 and Z_n represents spatial locations of first and last slices selected for imaging, and opslthick represents a desired imaging slice thickness.

6. (Allowed) The method of claim 5 further comprising creating the re-inversion pulse with a center centered about a midpoint between Z_1 and Z_n.

7. (Allowed) The method of claim 1 wherein the timing step includes selecting an inversion time TI such that the null point of the blood occurs near a center of the multi-slice acquisition.

8. (Allowed) The method of claim 1 further comprising modifying a flip angle of RF excitation pulses executed before and after an occurrence of the null point of the blood to improve blood suppression.

9. (Allowed) The method of claim 8 further comprising modifying the flip of RF excitation pulses occurring before the null point to slightly less than 90° and those occurring after the null point to slightly more than 90°.

10. (Allowed) A computer program stored on a computer readable storage medium and having a set of instructions that when executed by a computer cause the computer to:

(A) generate and cause application of a non-selective inversion RF pulse to a slab of slices each having a thickness;

(B) generate and cause application of a slice-selective re-inversion RF pulse having a slice thickness greater than the thickness of a single slice;

(C) apply an inversion time;

(D) apply RF excitations; and

(E) acquire MR data.

11. (Allowed) The computer program of claim 10 wherein the slice thickness of the re-inversion pulse is selected greater than the slab of slices to allow for cardiac motion between the application of the slice-selective re-inversion RF pulse, and the acquisition of MR data.

12. (Allowed) The computer program of claim 10 wherein the RF excitations have a flip angle greater than 90° for segments after a null point and less than 90° for segments before the null point.

13. (Allowed) The computer program of claim 10 wherein acts (A) – (E) are carried out over one or more R-R intervals.

14. (Allowed) The computer program of claim 10 wherein the MR data is acquired during mid-diastole of an R-R interval.

15. (Allowed) An MR apparatus to produce consistent contrast in image acquisition comprising:

a magnetic resonance imaging (MRI) system having a plurality of gradient coils positioned about a bore of a magnet to impress a polarizing magnetic field and an RF transceiver system and an RF switch controlled by a pulse module to transmit RF signals to an RF coil assembly to acquire MR images; and

a computer programmed to apply a pulse sequence having:

a non-selective inversion pulse to invert spins in a longitudinal direction across an entire slab of slices;

a slice-selective re-inversion pulse having an implied width at least as large as that of the non-selective inversion pulse; and

a series of excitation pulses spaced apart from the slice-selective re-inversion pulse by an inversion time.

16. (Allowed) The MR apparatus of claim 15 wherein the slice-selective re-inversion pulse of the pulse sequence is further defined as having a width greater than that of the non-selective inversion pulse to extend on either side of the non-selective inversion pulse.

17. (Allowed) The MR apparatus of claim 16 wherein the slice-selective re-inversion pulse extends approximately twice the nominal slice thickness on either side of the non-selective inversion pulse.

18. (Allowed) The MR apparatus of claim 15 wherein the inversion time of the pulse sequence is selected such that blood signal is close to a null point.

19. (Allowed) The MR apparatus of claim 18 wherein the series of excitation pulses have therein excitation pulses with differing flip angles.

20. (Allowed) The MR apparatus of claim 19 wherein excitation pulses occurring near a mid-point of the series have a flip angle near 90° and excitation pulses occurring before a mid-point have a flip angle less than 90° and excitation pulses occurring after the mid-point have a flip angle more than 90°.

21. (On Appeal) A pulse sequence for use in multi-slice MR data acquisition comprising:

a non-selective inversion pulse applicable to a slab of slices;

a slice-selective re-inversion pulse applicable to at least a number of slices in the slab of slices; and

a series of excitation pulses applicable to the at least a number of slices in the slab of slices after an inversion time.

22. (On Appeal) The pulse sequence of claim 21 wherein the inversion time is selected to allow signal from blood in a mid-point of the at least a number of slices to approach a null point.

23. (On Appeal) The pulse sequence of claim 21 wherein the at least a number of slices includes all slices in the slab of slices.

24. (On Appeal) The pulse sequence of claim 21 wherein the at least a number of slices includes fewer slices than those in the slab of slices but more than one.

25. (On Appeal) The pulse sequence of claim 21 wherein the at least a number of slices includes more slices than those in the slab of slices.

26. (On Appeal) The pulse sequence of claim 21 wherein the non-selective inversion pulse has a thickness given by:

slice thickness = $(Z_1 - Z_n) + 4 * opslthick$,

where Z_1 and Z_n represents spatial locations of first and last slices selected for imaging, and opslthick represents a desired imaging slice thickness.

27. (On Appeal) The pulse sequence of claim 26 wherein the slice-selective re-inversion pulse has a center centered about a mid-point between Z_1 and Z_n.

28. (On Appeal) The pulse sequence of claim 21 wherein the series of excitation pulses have varying flip angles.

29. (On Appeal) The pulse sequence of claim 28 wherein excitation pulses that occur before a mid-point of the series have a flip angle of less than 90°, those near the mid-point have a flip angle near or at 90°, and those that occur after the mid-point have a flip angle greater than 90°.